editor comments :

Dear authors,

Thank you very much for the revision which has been well received by both original reviewers. One of the reviewers has three remaining points which I would like you to address. Also, the other reviewer noted that he/she had a typo in the original review and sent me the following note:

"In my last comments, I commented as follows: When the laser beam and the receiver filed are focused, the reviewer thinks that the wind filed at the focusing volume will be no longer the repetitiveness around the plane. The refractive turbulence is strong in the UV.
"the repetitiveness" was typo. "representativeness" is correct. If possible, I recommend to add an explanation sentence in the body."

I would thus welcome if you addressed also this comment in your final revision which I will review myself and then take a final decision on your manuscript.

Thanks in advance and best regards,

Markus Rapp
Assoc. Editor

General answer; We would like to thanks the editor and the reviewers for the revisions that will improve the article. We appreciate that "the revision has been well received by both original reviewers". We have addressed all of the concerns in the revised manuscript and have detailed them in the report below. Please consider this revised manuscript for publication.

Reviewer: "In my last comments, I commented as follows: When the laser beam and the receiver filed are focused, the reviewer thinks that the wind filed at the focusing volume will be no longer the repetitiveness around the plane. The refractive turbulence is strong in the UV.
"the repetitiveness" was typo. "representativeness" is correct. If possible, I recommend to add an explanation sentence in the body."

Answer:

We agree with the reviewer that the turbulence can affect the propagation of the laser beam in the atmosphere. This can result in beam wandering and difference between the expect focusing position and the real one. However, if this motion is smaller than 25 m, we don't think that this will affect significantly the results. Indeed, we have already considered the fact that, for each measurement integrated over 0.1 s, the focusing position changes over 25 m due to the plane motion (at 250 m/s). In the simulation, this had little effect on the error of the reconstructed wind velocity. This is likely due to the fact that, for a "Von Karman" statistical model, at high frequency, the amplitude of the harmonic get very small (so the wind does not vary significantly over short distances). However, this effect will be addressed in more detail in future studies that will account for beam refraction in turbulences.

To support the explanations, and to be consistent with the simulations described after in the paper, we remade the calculations of the RMSE as a function of lidar angle for a Von Karman turbulence with $\sigma = 10\ m/s$. This implies the following modifications:

- The figure 5 was updated with a standard deviation of the wind amplitude of $\sigma = 10\ m/s$
- We modify line 315 as follow: "… a Von Karman turbulence with l equal to 762 m (2500 ft) and σ_S, the standard deviation of the wind amplitude equal to 10 m s-1 …"
- We modify line 317 as follow: "The RMSE obtained for this angle is 7.2 m s−1, nearly twice as low as the RMSE of 12.7 m s−1 obtained for an angle of 15°"
- We modify line 330 as follow: "Additionally, we assume a turbulence strength σ_S of 10 m s-1"
- We modify line 350 as follow : " … we assume a turbulence with a standard deviation of the wind amplitude of 10 m s-1"
- We propose to add line 351: "…located in the nose of the aircraft. In particular, for each measurement, we account for the plane motion during the integration time, that is to say the slight variation of the measured projected wind observed by each laser pulse…."
- We propose to add line 366: "… . This illustrates the improvement achieved with the optimized lidar angle of 50◦. In addition, the result is close to the theoretical RMSE given in Fig. 5b). This shows that the motion of the plane during the integration time (i.e. 25 m) has little effect on the error in the wind reconstruction."
- And Line 402 in the conclusion : "The effect of refraction due to turbulence has not been taken into account in the 3D wind simulator. In the UV, the refraction is strong and the beam can be significantly deflected as it propagates through the atmosphere. This can lead to an increase in the size of the probe volume, depending on the direction of the refraction. This will be addressed in future studies."

referee comments :

The authors have adequately addressed most of the issues I raised and revised the manuscript accordingly. I recommend publication after minor revisions as follows:

1. The major limitations of the end-to-end simulator, discussed in the response letter, should be included in the manuscript. Specifically, the assumption of a perfect interferometer with a contrast of 1, and the fact that reduced contrast due to optical imperfections will be addressed in a refined simulator, are noteworthy and should be mentioned.

2. In Fig. 5, the RMSE values should use the correct punctuation, for example, 2.33 m/s instead of 2,33 m/s. Additionally, units should be written in exponential form ($m\ s^{-1}$) in the axis labels to comply with AMT style guidelines. This also applies to some labels in other figures.

3. It is unfortunate that the authors did not study the reproducibility or variability of the RMSE across multiple simulation runs. They should at least provide an estimate of how the RMSE values vary and indicate that a more detailed sensitivity study will be performed in the future.

1. **Referee: The major limitations of the end-to-end simulator, discussed in the response letter, should be included in the manuscript. Specifically, the assumption of a perfect interferometer with a contrast of 1, and the fact that reduced contrast due to optical imperfections will be addressed in a refined simulator, are noteworthy and should be mentioned.**

Answer: We add in the conclusion line 381: "…to refine the calculation of the performances of the system. Currently we assume a perfect interferometer with all transmission of the optics equal to 1 and an instrumental contrast of 1. This will be reevaluated in future studies with transmission and contract measured experimentally."

2. **Referee: In Fig. 5, the RMSE values should use the correct punctuation, for example, 2.33 m/s instead of 2,33 m/s. Additionally, units should be written in exponential form ($m\ s^{-1}$) in the axis labels to comply with AMT style guidelines. This also applies to some labels in other figures.**

Answer: it has been corrected

3. **Referee: It is unfortunate that the authors did not study the reproducibility or variability of the RMSE across multiple simulation runs. They should at least provide an estimate of how the RMSE values vary and indicate that a more detailed sensitivity study will be performed in the future.**

Answer:

In this study, the RMSE is actually evaluated by comparing the reconstructed wind with the actual wind along the flight path, that is to say, over ~300 independent cases (that represent approximately 8 km divided by 25 m the size of the volume integrated over 0.1s at 250 m.s^{-1}) at each run of the simulator.

We followed the advice of the referee, whom we thank, and. perform multiple run of simulation to have a better evaluation of the RMSE. Results of RMSE obtained with 180 runs of the simulations show a mean value of 12.7 m.s^{-1} with a 3σ error of 0.3 m.s^{-1} for the angle of 15° and a mean value of 7.2 m.s^{-1} with a 3σ error of 0.15 m.s^{-1} for the angle of 50°.

To explain this point, we modified line 358: "…for the Merion C. Once the wind components are estimated, the RMSE is estimated at each simulator run, using the mean value of the squared differences between the estimated wind component and the true wind component over the flight path over 312 values (~8 km/25 m), and taking the square root of the resulting value. Figure 6 displays the results…."

We remove the sentence line 364 and add the following explanation: "~~The corresponding RMSE obtained for this run of the simulation are 12.9 m s−1 for an angle of 15° and 7.4 m s−1 for an angle of 50°~~. 180 simulation runs have been performed and statistics on all obtained RMSE shows a mean value of 12.7 m.s^{-1} with a 3σ error of 0.3 m.s^{-1} for the angle of 15° and a mean value of 7.2 m.s^{-1} with a 3σ error of 0.15 m.s^{-1} for the angle of 50°. This illustrates the improvement…"

Additional modifications to improve the readability of the article.

- σ^2, define as the variance of the turbulence, can be confusing and not well defined in the text. Moreover, σ appears to many times in the article, for different physics parameters and mathematics function. So we decided to explained it as σ_S the standard deviation of the wind amplitude in the turbulence.
- We modify line 310 as follow: " … σ_S the standard deviation of the wind amplitude in the turbulence, l the turbulence length scale,…"
- We add line 311 the following explanation on σ_S: "The standard deviation of the wind amplitude is related to the spectrum energy E_v(k) of the wind field with the equation $\int_0^\infty E_v(k)\,dk = \frac{3\sigma_S}{2}$ (Wilson,1998), where k represents the spatial frequency."
- To avoid repetition, we delete line 340 the following sentences: "… represent the direction (x, y, or z), ~~k represents the spatial frequency, Ev(k) is the spectrum energy of turbulence~~, and δij is the Kronecker delta…"
- In equation (6), (7), (8) and all other equations where this physics quantity appears, σ has been replaced by σ_S.
- We modify line 340 as follow: "For Von Karman turbulence, Ev (k) = $1.4528\frac{\sigma_S{}^2k^4l^2}{(1+k^2l^2)^{17/6}}$ ~~where σ_S denotes the variance of turbulence~~. (already define line 315)"
- We correct line 350 : ".. 762 m, value at 10 km of altitude, and .."
- We modify line 352 as follow: "…Vaircraft =250 m s−1, that it is centered at y = 0 and z = 0, along x axis, and that the lidar is located in the nose of the aircraft…"
- We modify line 355 as follow: "We used a simplified model for the lidar, considering, at each pulse, only one measurement on the laser axis of the projected wind speed at a range z = d/ cos (θ) over a range gate of 25 m."
- We correct line 362 : "… In Fig. 6.b), the green line, that corresponds to the vertical component retrieved using a lidar angle of 50…"
- We correct line 362 :"… using a lidar angle of 50◦, is closer to the black line, that represents the real wind, than the red line, that corresponds to the vertical component reconstructed using a lidar angle of 15◦ …"